Amrita School of Engineering, Bengaluru-35

23MAT106
Mathematics for Intelligent Systems – 1
Lab Material

Creation of vectors, matrices, vector operations and matrix operations (for 2 lab sessions)

- **Go to Octave online / MATLAB and type the following in the command prompt**

x=[1 2 3 4 5 6 7]

x=[1,2,3,4,5,6,7] — Creates a row vector

- y=[1;2;3;4;5] — Creates a column vector

- A=[1 2 3;4 5 6;7 8 9]
  B=[20,12,16,44;54, 4, 62, 28] — Entry of a matrix

- length(x), length(y)
- size(A), size(B)
- B', transpose(B)

- x1=ones(1,10) — Creates a 1 x 10 row vector with all components as ones

- y0=zeros(5,1) — Creates a 5 x 1 column vector with all components as ones

- M = zeros(3,4) — Creates a 3 x 4 matrix with all components as zero

- eye(4)
  eye(5,8) — Creation of identity matrix

- z1=1:10 — Creation of a row vector from 1 to 10 with a default increment 1

- z2=5:3:26
  z3=26:-3:5 — a:c:b
  Creation of a row vector from a to b with an increment of c

- L=[1,2,3;4,5,6;7,8,9;8,3,4]
  u=L(2,:)
  v=L(:,3)
  w=L(1:2,2:3) — extracts the specific rows, columns, submatrices

- E=[2,9,12;9,6,-2;2,8,10]
  a=E(2,3)
  b=E(1,2)

  Extracts a specific element from matrix

- E, p=[9 8 7], F=[E;p]

  appends E with a new row vector p

- F, q=[1 2 3 4], G=[F q']

  appends F with a new column vector q

- M=[1,2;3,4]; M(:,2)= M(:,2)+1

  Replaces the second column $[2,4]^T$ to $[3,5]^T$

- x=[9 3 1 5 7]
  sort(x,'ascend'), sort(x,'descend')

  Sorts the vector in ascending or descending order

- sum(x)
  max(x), min(x)
  mean(x), var(x), std(x)

  Finds the sum, maximum value, minimum value, mean, variance and standard deviation of elements in x

- dot(p,q)
- cross(p,q)

  dot product and cross product of vectors

- p=[30 20 50]; q=[-20 40 70]; A=[1,2,3;2,3,4;4,5,6]; B=[4,9,4;1,9,16;25,9,4];
  p+q, A+B, p-q, A-B

  Addition and subtraction of Vectors/Matrices

- 2*q, 3*A, B/4

  Scalar multiplication to a vector/matrix

- p+2, A+3

  Adds two to every element of the vector/matrix

- exp(p), log(p), sqrt(B), sin(A),etc

  component wise evaluation

- A*B, p*q', p'*q, A^2

  Matrix multiplication

- p.*q, A.*B

  component wise multiplication of vectors/matrices of equal size

  Eg: [1 2 3].*[2 3 4]=[2 6 12]

- M=[1,2;3,4]; N=C.^2

  Each element of the matrix is squared

- L=[1 2 3;4 5 6;7 8 9];
  D=det(L)
  I=inv(L)
  T=trace(L)

  Finds the determinant, inverse, trace of the matrix

  DE=diag(L)

  Finds the diagonal elements and write it as a vector

- V=[2,3,4]; diag(V)

  Forms a diagonal matrix with elements from vector V

- P=[1,2,3,6;2,3,4,9;3,4,5,12]; rref(P)

Gives row reduced echelon form of the matrix M

- A=[1 2 3;4 5 6;7 8 9];b=[6;15;24];X=A\b
- A=[1 2 3;4 5 6;7 8 9];b=[6;15;24];X=inv(A)*b

Solves the system AX=b

Practise Questions (Vectors and Matrices):

1. Evaluate the following for $\bar{x} = (-9\ 8\ 7)$, $\bar{y} = (1,2,-3), \bar{z} = (11,0,2)$ using Matlab/Octave
   (a) $\bar{x} \cdot \bar{y}$ (b) $\bar{x} \times \bar{y} \cdot \bar{z}$ (c) $\bar{x} \cdot \bar{y} \times \bar{z}$ (d) $(\bar{x} \times \bar{y}) \times (\bar{z} \times \bar{x})$ (e) $(2\bar{x} \times 5\bar{y}) + 9\bar{z}$
2. The marks of all students in a class for a mathematics exam is given below :
   21,99,45,97,15,89,100,78,68,37,44,56,77,88,99,22,19,3,50,44,78,98,86,65,91,51
   Answer the questions after entering these marks as a vector in Matlab/Octave command window.
   (a) How many students are there in the class?
   (b) What is the class average in mathematics?
   (c) What is the maximum mark? minimum mark?
   (d) Write all the marks in (i)ascending order and (ii) descending order.
3. If $P=\begin{bmatrix}99 & 12 & 3\\ 4 & 43 & 6\\ 77 & 65 & 49\end{bmatrix}$, $Q=\begin{bmatrix}91 & 22 & 35\\ 14 & 42 & 16\\ 72 & 43 & 51\end{bmatrix}$ and $R=\begin{bmatrix}1 & 2 & 3\\ 4 & 9 & 8\end{bmatrix}$
   (i) Find (a)3P+Q-PQ (b) QR^T (c) RQ-R (d) P^2Q (e) $(P+Q)^2$ (f) $|P|$ (g) P^{-1}
   (ii) Find the vector consisting of diagonal elements of P+Q.
   (iii) Find the trace of (i)P+Q and (ii)PQ.
   (iv) Create an identity matrix of order 15.
   (v) Obtain the third row of P+Q and call it as vector u.
   (vi) Obtain a 4×3 matrix by appending P with u.
   (vii) Obtain the second column of P+Q
4. If $A=\begin{bmatrix}9 & 1 & 3\\ 4 & 4 & 6\\ 0 & 5 & 4\end{bmatrix}$, B=[24 56 78]^T in the system of equations AX=B.
   (i) Write the augmented matrix AB, (ii) Find $X=A^{-1}B$
5. If $P=\begin{bmatrix}10 & 3 & 13\\ 44 & 21 & 62\\ 7 & 35 & 49\end{bmatrix}$, $Q=\begin{bmatrix}931 & 232 & 345\\ 154 & 462 & 186\\ 722 & 463 & 501\end{bmatrix}$, verify (i) $(PQ)^T=Q^T P^T$ (ii) PI=IP=P.
6. Solve the linear system 2x+3y-z=4; 3x-8y+6z=1; x+y+10z=12 using MATLAB.
7. Use MATLAB commands to create the following matrices (do not enter the matrices directly):

$$A = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \qquad B = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \qquad C = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$D = \begin{pmatrix} 2 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 0 & 2 \end{pmatrix}, \qquad E = \begin{pmatrix} 1 & 2 & 0 & 0 & 0 \\ 3 & 7 & 0 & 0 & 0 \\ 0 & 0 & 3 & 0 & 0 \\ 0 & 0 & 0 & 3 & 0 \\ 0 & 0 & 0 & 0 & 3 \end{pmatrix}$$

$$F = \begin{pmatrix} 2 & 0 & 0 & 0 & 1 \\ 0 & 2 & 0 & 0 & 1 \\ 0 & 0 & 2 & 0 & 1 \\ 0 & 0 & 0 & 2 & 1 \\ 0 & 0 & 0 & 0 & 3 \end{pmatrix}$$

8. Create a row vector of all prime numbers between 4 and 40.
9. Create a column vector of all numbers corresponding to the alphabets in your name.
10. Create a 1 x 5 vector A with all elements equal to 0 (without directly entering the rows).
11. Create a 4 x 5 matrix of all zero elements.
12. Create the following Matrix P=$\begin{bmatrix} 10 & 3 & 13 \\ 44 & 21 & 62 \\ 7 & 35 & 49 \end{bmatrix}$
    a. Find the transpose of P;
    b. Display the element P_{13} of the matrix P.
    c. Display the second row of the P.
    d. Display the third column of P
    e. Find the determinant of P
    f. Find the inverse of P
    g. Multiply $P^{-1}P$ and PP^{-1}
    h. Find PP^T and P^TP
    i. Create a matrix which has elements as square of each element of P.
    j. Find P^3.
    k. Create a matrix which has 2 added to each element of P.
    l. Find the trace of the following matrices: $P^{-1}P$, P^TP, 3P, -P

13. Create a diagonal matrix with the diagonal elements as elements of the vector [2,-6,7,3,2,7].
14. Write the augmented matrix AB for the following linear system of equations, write it in row-reduced echelon form using MATLAB and solve. Mention what the solution geometrically represents.
    a) 3x+3y-z=4; 3x-8y+6z=7; x+y+10z=22
    b) 4x-3y+2z+5w=10; 9x-2y-3z+6w=7; 2x+11y+3z-6w=13; 8x-3y+5z-w=14
    c) x-3y+2z+5w= 3; 2x-2y+3z+6w=11; 2x+11y-3z-6w=40; 5x+6y+2z+5w=54
    d) 4x-3y+2z+5w=10; 9x-2y-3z+6w=7; 5x+1y-5z+w=13; 8x-6y+4z+10w=20
    e) x+y-z=7; 2x-2y+3z=9; 3x+2y-5z=10
15. Another way of solving a system AX=B using MATLAB is to use the command, X=A\B. Which of the systems in Question 14 can be solved using this method? Explain.
16. Another way of solving a system AX=B using MATLAB is using inverse, $X = A^{-1}B$. Try to find the solution of systems in Q.14 using this way.